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Perception of Risks from Electromagnetic Fields: Lessons for the Future

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Abstract. Technologies based on extremely high frequency electromagnetic fields, in particular in the terahertz region, are quite recent and new to the public. While a number of advantages have been shown, especially in the biomedical area, biological effects and possible health implications have not been fully investigated. The experience gained with electromagnetic fields of lower frequencies, from ELF to microwaves, suggests that innovating technologies may create concern, or even fear, among the public for hypothetical health risks. Social research has shown that worries are related to the perception of risks by the public more than to their actual existence. Risk perception depends on several factors, many of which are relevant for electromagnetic fields. They include lack of familiarity with the agent, difficulty in understanding interaction mechanisms, and uncertainty in scientific knowledge. Lessons learnt from the past lead to recommend that specific research on biological effects of terahertz radiation be started from the very beginning of the development of technological applications and that a continuous and effective dialogue be established between the scientific community and the public.

Key words: Risk perception, safety, Terahertz radiation

1. Introduction

Extremely high frequency electromagnetic fields, in particular terahertz (THz) radiation, are finding increasing applications, from medical diagnosis to telecommunications. While possible benefits are evident, little is known about health risks. Controversies that have been raised about other kinds of electromagnetic fields have shown how the acceptance of new technologies may be hampered by a distorted perception of risks by the general public. Therefore, an analysis of mechanisms of risk perception, and the way such perception might influence the development of THz technologies, is appropriate.

2. Health Risks of Electromagnetic Fields

The International Agency for Research on Cancer has recently issued a monograph on the cancerogenicity of extremely low frequency (ELF) magnetic fields [1]. These have been classified as 'possibly carcinogenic' for humans, based on limited epidemiological evidence of childhood leukaemia.

The evaluation confirms previous conclusions of an international expert panel convened by the US National Institute of Environmental Health Sciences (NIEHS) in the frame of the RAPID project [2]. In a commentary document [3], the World Health Organization (WHO) underlines that 'possibly carcinogenic' is the weakest of three categories used by IARC to classify agents for which a role in the development of tumours cannot be excluded. It is to note that a number of individual scientists had previously expressed an opinion in favour of a classification of ELF magnetic fields as 'probably carcinogenic'. In effect, most recent findings of both epidemiological and laboratory studies have weakened the evidence supporting the hypothesis of carcinogenicity. At the same time, epidemiological data suggest that the risk, if any, is lower than estimated based on previous studies: analyses carried out in different countries consistently indicate that the number of excess cases of childhood leukaemia attributable to power lines, in the hypothesis of an actual carcinogenicity of magnetic fields, is of the order of the unity, over the whole country.

As regards radiofrequency (RF) fields. WHO notes that 'a scientific review ... concluded that, from the scientific literature, there is no convincing evidence that exposure to RF shortens the life span of humans, induces or promotes cancer' [4]. A later document specific to mobile telephony [5] confirms such conclusion, that has later been strengthened by a number of epidemiological and biological studies.

In summary, the opinion of the scientific community is quite reassuring about possible health risks of both low- and high-frequency electromagnetic fields. In spite of that, worries of the public about power lines, broadcasting antennas, base stations for mobile telephony and other sources of electromagnetic fields persist and, in some countries, have even increased in last times.

3. The Public Perception of Risks

The perception of health risks is therefore quite different between scientists and the public. Such divergence is crucial in the debates and controversies about electromagnetic fields; it is significant that the International EMF Project of WHO (`www.who.int/emf`) includes, along with traditional research lines, studies on the mechanisms of risk perception and communication.

Research on risk perception has initially developed in connection with nuclear energy, to cope with the difficulties of communication between experts and lay people. It has later found application in different areas, growing up to constitute an independent branch of social sciences. Many concepts of general validity have been developed, that can be of use for electromagnetic fields.

Major causes of different perception are undoubtedly the limited ability of experts to communicate risks to the public, and an attitude of media to privilege sensationalism rather than a correct transfer of information. However, difficulties in scientific communication have objective causes in the quality of data, that are still controversial, sometimes contradictory, and in any case difficult to read and

Table I. Factors influencing the perception of risks (in italic, factors relevant for electromagnetic fields)

Catastrophic potential	*Trust in institutions*
Familiarity with the agent	*Attention of media*
Understanding of mechanisms	Previous accidents
Uncertainty of knowledge	*Equity of risks and benefits*
Controllability of risk	Clarity of benefits
Voluntarity of exposure	*Irreversibility of effects*
Effects on children	Personal involvement
Effects on future generations	*Scientific evidence*
Indentificability of victims	*Human or natural origin*
Relevance of effects	

interpret. Therefore, risk assessment faces two main problems: on one side, the correct analysis of scientific data, on the other the understanding of mechanisms of risk communication and perception.

Risks are perceived differently based on their quality. Table I lists factors that have been identified as specially relevant for the psychological attitude towards risks of a given agent, technology, or human activity.

As shown in the Table, most of these factors are of special importance for electromagnetic fields. Emotional impact of risks for children is probably the most relevant, but involuntarity, uncertainty in knowledge, and limited understanding of interaction mechanisms, are likely to play a significant role.

Other factors specific to electromagnetic fields must be added to the general list: they include imperceptibility, visual impact of antennas and power lines, and use of the term 'non ionizing radiation' that may induce to erroneous analogies and extrapolations.

4. Health Consequences of Risk Perception

A distorted perception of risks is not just a social issue. It strongly affects the psychological attitude of non-experts towards electromagnetic fields, with possible consequences on the health status. This aspect is made clear in the final report [6] of a study group set up by the European Commission to investigate subjective symptoms (i.e. psychological and neurovegetative disturbs) attributed to electromagnetic field exposure. Several medical reports were reviewed of symptoms such as headache, asthenia, weakness, irritability, that patients or physicians attributed to electromagnetic fields.

The study group concluded that most symptoms – if not all – were of psychosomatic origin. In controlled tests, the symptoms came out to be statistically correlated to the degree of worry of patients, while no significant association with

Table II. Proportion of persons claiming subjective symptoms according to their worry about ELF magnetic fields

	Not worried	Worried
No symptoms	50%	31%
At least one symptom	50%	69%

exposure was found. As an example, Table II shows the findings of a study [7] on people living near power lines: the incidence of subjective symptoms is higher in subjects who are worried about the effects of magnetic fields, rather than in subjects actually exposed.

However, suffering of these patients is true, and sometimes even intolerable. This confirms a hypothesis put forward by several social scientists and medical doctors: a distorted perception of risks may cause excessive or unjustified worries, which in turn may cause real health effects. In conclusion, distorted perception of risks should be seen as a health problem *per se*, and actions should be taken to remove its causes.

Among factors listed in Table I, information requires special consideration. Science is intrinsicly problematic: data of research are always uncertain, and provisional. The public, on the contrary, requires clear and definitive answers, a request often satisfied by media reporting sensational health effects that would have been 'proven' by some research team. Such messages, explicit and direct, are clearly incorrect; but even worse are messages that we could call 'indirect', and that generally penetrate much more easily. Examples include: advertisement for protection devices whose effectiveness is unclear; inconsistent and contradictory juridical sentences; indiscriminate prohibition of use of mobile phones even in areas where interference is implausible; innumerable 'good advices' for the safe use of mobile phones, domestic appliances and other devices; last – but perhaps most important – cautionary measures with no scientific justification.

The case of base stations for mobile telephony is a good example. Simple theoretical considerations indicate that realistic exposure are well below limits set by international regulations. Experimental surveys carried out in various areas of the world confirm this expectation; results can be found in official reports available online [8–11]. In spite of this, systematic and detailed measures on each individual base stations are requested in some countries, as well as continuous monitoring of emissions. Similar measures unavoidably transmit to citizens the message that exposure levels of base stations are, or may be, beyond acceptable levels.

5. Lessons for the Future

At present, human exposure to THz radiation is mainly limited to medical applications, with clear benefits for the patients. However, the physicians' code of behaviour requires that any practice be justified – also in comparison with alternatives – based on a balance of risks and benefits. Medical doctors do therefore need adequate knowledge of possible health hazards of THz radiation, and investigations in this area should be promoted and encouraged.

Such research is further justified by the consideration that THz radiation is expected to find significant applications in other fields than medicine, for example for automatic control systems of vehicles, that may involve exposure of large fractions of the population. The experience has shown that the acceptance of new technologies may be severely hampered by fears due to a distorted perception of risks and it is therefore important that research findings are made available to the public, timely and in an accessible way.

Several aspects of THz radiation can in fact negatively influence the attitude of the public; they include lack of familiarity with the physical agent, difficulty of understanding interaction mechanisms, and scientific uncertainties.

We have learnt useful lessons from the past: scientific research on possible hazards should accompany from the very beginning the development of new technologies; a balanced wheight of evidence should be presented and updated in the light of new findings; more in general, a continuous, honest and effective dialogue should be maintained between the scientific community and the public.

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